



Ø BEAT



COLO. SPRINGS,
COLORADO

OCTOBER 1982

How Does This Thing Work??

COMPUTERS PART III

With the advent of Integrated Circuits, computer design philosophy evolved to that which we know today. At this point, it's time we examine the design philosophy of a computer to see how it works. To begin examination, let's restate the definition of a computer:

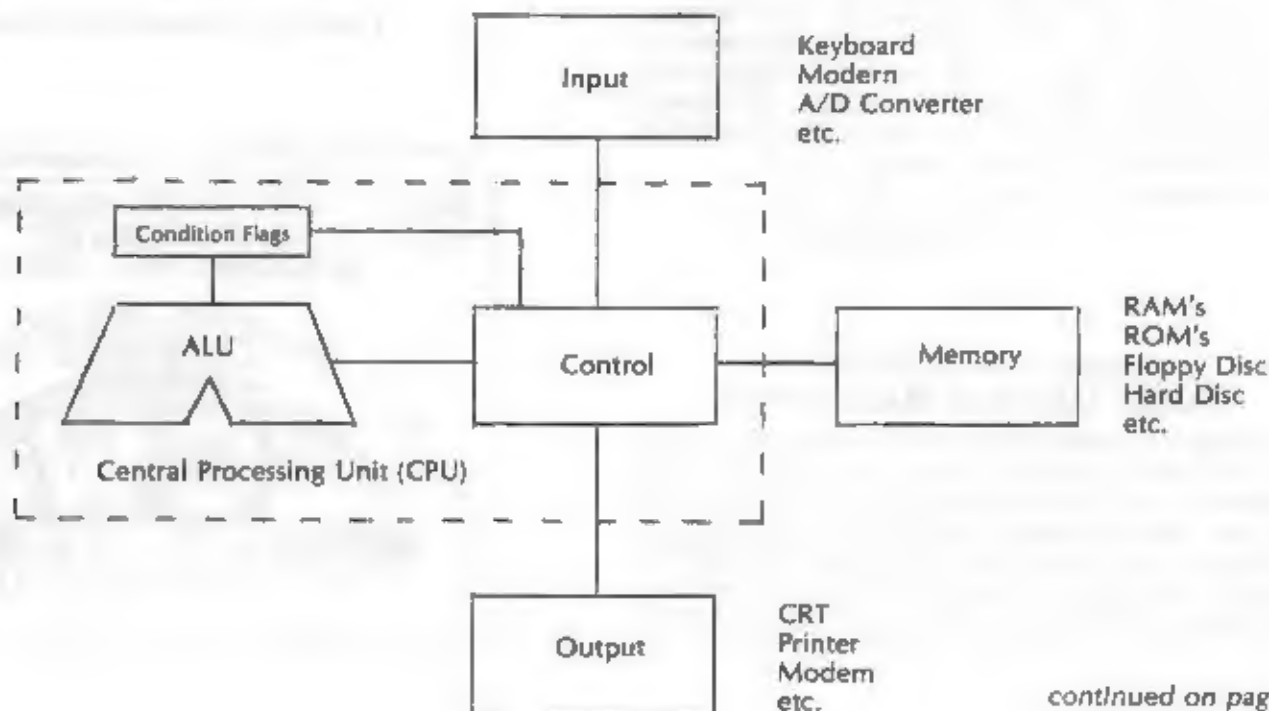
A computer is a mechanical, electromechanical or electronic device that can input, store, process and output data.

Don't forget, data can be any type of alphabetic or numeric information. From the definition, we find that a computer has five parts. Remember, it has to have these five parts or it can't be called a computer!

1. Input — needs some method of inputting data
2. Storage — also called memory
3. Processing — called the arithmetic logic unit or ALU
4. Control — not specifically named in the definition but consists of the decision electronics that addresses, turns on and off and moves data to and from the other four parts of the computer.
5. Output — puts data into a form that can be understood after processing is complete.

Figure 1 shows the five parts of a computer in more detail.

Fig. 1



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The Pikes Peak Radio Amateur Association meets on the second Wednesday of every month at the First United Methodist Church, 420 N. Nevada, at 7:30 p.m. All amateurs and interested parties are invited to attend.

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SEPTEMBER MEETING MINUTES

The meeting was called to order at 7:32 PM by president Al Bailey, ADØZ. The August minutes were accepted and committee reports were presented.

The RFI committee is investigating one case of television interference. Any reports of interference can be directed to Greg, KAØFOZ.

A novice class will be held beginning 21 Sept. on Tuesday and Thursday evenings. A request was made for a volunteer to help with code.

Don, KBØKQ, requested two volunteers to help with the Run for the Sun event to be held at the Air Force Academy, Saturday, 11 Sept.

Sportsfest Certificates were presented by Ken, WØTGL, and a reminder issued about the clubs involvement in communications for the '83 Sports Festival. Approximately 100 amateurs will be needed.

After a short break, the meeting was resumed with a presentation on radio frequency interference, sponsored by the Colorado Springs Department of Public Utilities. Mark Swan of the utilities department introduced the speaker for the evening, Bill Nelson, WA6FQG. Many thanks to Mr. Nelson and the CSPDU for an informative and entertaining program.

The meeting was adjourned at 10:00 PM.

Respectfully submitted,
Greg, KAØFOZ

Thanks to the PIKES PEAK RADIO AMATEUR ASSOCIATION

Last March I bought a Kenwood TR-2400 H.T. to use in Civil Air Patrol work. I purchased it from Larry Rice, who suggested I look into becoming a "Ham" so that I could get more use and enjoyment from my new acquisition. Through a copy of Zero Beat, I obtained Don's KBØKQ phone number and learned of his novice theory class and Dave's NØDV Code Class, both of which I joined.

Don's theory class was thought provoking and

enjoyable. I had had an electrical course in college and classified it as something I would never be able to understand. But now I couldn't put the novice book down and with Don's explanation, I was actually learning and enjoying.

Without Dave's tapes and encouragement, the code would have been a pitfall. Instead it was a fun and challenging experience.

I have now passed the Technician class and I am diligently working on my code speed to obtain the General. Who knows what lies beyond?

So thanks PPRAA for sponsoring the classes, and a special thanks to Dave NØDV and Don KBØKQ for their time and effort. I am sure I speak for past, present and future Ham students.

Bill Richardson
KAØOQZ/DV

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Computers (cont.)

Let's look at each of the parts a little more closely.

INPUT — These devices can take many forms such as keyboards, card readers, modem's, A/D converters, joy sticks and many different kinds of switches and sensors. Whatever the input device is, it must translate the data being input from the outside world to a format the computer can understand. The input device most familiar to many of us is the keyboard. The most common output format of keyboards is ASCII (American Standard Computer Input Interface). An ASCII output character (often called word) is seven binary digits (called bits for short) in length. There is also an eighth bit called a parity bit. It is an optional bit used for testing the input and is often not used.

OUTPUT — An output device puts our processed data into a form that can be understood by what ever is requesting the data. Almost anything could be requesting the data: another computer, a telephone line, a teletype transmitter, a piece of the test equipment or even a person. Therefore, the output device can take many forms like a CRT, Printer, MODEM (telephone or teletype interface), D/A converter, LED display, relay network, etc. Obviously, the ones we're most familiar with are the CRT and printer. These output devices put the processed data into a form that we can understand which is alphanumeric characters.

MEMORY — Computer memory is exactly what it seems it should be. Memory stores data. A computer uses different kinds of data during its operation. There is information that is input, processed by our program and outputted. Both the information and program data are called transient data. Under normal circumstances neither the program nor the information needs to stay stored in computer memory for a long time. That's what transient means. When you're done running your program, you can take your output, turn off the computer and walk away. The data is not saved inside the computer. This type of data is stored in "Volatile" Memory. Data stored in volatile memory is not saved when power is turned off.

Most of a computer's main memory is made up of

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volatile memory chips called RAM's (Random Access Memory). The most popular type of RAM in use in computers today is the Dynamic RAM. Dynamic RAM chips are made up of many tiny capacitors that can be charged to read a "1" or discharged to read a "0". The problem with dynamic RAM-s is that the dielectric resistance of these capacitors is not very high and they discharge very quickly. So in most systems (particularly ones that use a Z-80A CPU) the central processor spends part of its time restoring or "refreshing" the charge on the RAMs every few milliseconds when it could be doing other things instead. These systems are less efficient than ones using other storage techniques such as static RAMs. But there is also a positive side for using dynamic RAMs. They are cheap compared to static RAMs. Where cost is an important factor, such as in commercial personal computer, dynamic RAMs are almost always used. Therefore dynamic RAMs are used in most commercial home computer designs.

Static RAMs are also a type of volatile memory, so it is correct to assume that the data is also lost when power is turned off. The difference with these chips is that once input, data remains stored as long as power is applied. There are no tuning or refreshing problems to worry about. Fortunately, the cost of static RAMs is constantly going down as manufacturing techniques improve. If you are planning to build your own computer, using the system efficient static RAMs should not be financially prohibitive.

Not all data can be considered to be transient data. There are frequent situations where the computer will use certain data over and over. For example, if a computer receives ASCII input but on a routine basis must output Binary Coded Decimal, a conversion table should be retained in memory and should be available for future use whether power is left on or not. Also, every computer needs what is called an initializing program. A typical initializing program may first clear the CRT screen, clear memory, transfer control to the

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Computers (cont.)

keyboard and then wait for an input. Without a permanent initializing program, a computer can not work at all. All these data, look up tables, Initializing programs frequently used subroutines, and even programming language interpreters must all be stored in non-volatile memory.

The most common form of non-volatile storage used in main memories is the ROM, or Read Only Memory. A ROM is unique in that the data is either permanently or semi-permanently stored in it. The computer can only "read" data from it, and can not "write" or store data into it. In the case of the standard ROM, the data is permanently fixed into it at the time of manufacture. The data can never be changed or erased. The PROM, or programmable read only memory, is a little more sophisticated. It is manufactured unprogrammed. The data is permanently "burned-in" later to fit each user's needs. Like the ROM, once the PROM data is programmed (or burned-in) it can never again be changed or erased. The EPROM, or erasable programmable read only memory, is at a still higher level of sophistication. The data can be burned-in in the field like the PROM, but it can also be erased with ultraviolet light. The EPROM is fairly low cost and is becoming the most used form of ROM. There is also an EEPROM (Electrically Erasable) that has recently been introduced on the market. Although it shows good promise, it is currently very expensive and difficult to obtain.

Other types of non-volatile memory include magnetic cores, magnetic tape, floppy discs and hard discs. With the exception of magnetic cores, these types of non-volatile memory are not generally used as a part of main memory. They are usually contained in added or peripheral equipment and are treated by the computer as another input/output source.

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ALU — The Arithmetic Logic Unit is the "brains" of a computer. The ALU with its associated condition flag register does all the arithmetic computations and sets up all the logic decisions for the computer. Some ALU's are very sophisticated and can make very complex computations without outside programming help. Others are fairly simple circuits. Most microcomputers have this kind of ALU. Like their calculator ancestors, microcomputer ALUs directly can only add and subtract. Multiplication is accomplished by a series of additions and register shifts and division is a series of subtractions and register shifts.

The function of the ALU is to take two data words (or bytes) transferred to it by the control section, arithmetically or logically process them and output the result. An important feature of the ALU is that it not only outputs the result; it also outputs the condition of the result. This is normally output to the Condition Flag Register. In many computers, particularly in microcomputers, this register receives and stores bits of data indicating five possible conditions of the result. Although some of these condition indicators vary from computer to computer the ones addressed here are very typical. The condition Indicators are:

1. **CARRY** — indicates an overflow condition exists. That means the result which was output by the ALU was too large to be processed within the size limitations of its registers.

2. **ZERO** — gives a quick verification that the result was equal to zero. The control section is often instructed to check to see if the flag is "on" without actually checking the result.

3. **SIGN** — indicates whether the sign of the result is plus or minus.

4. **PARITY** & 5. **AUXILLIARY CARRY** — these are valuable tools to the experienced programmer, but are not used anywhere near as often as the first three flags. We do not need to add to the confusion by addressing them in this article.

To quickly summarize, the ALU inputs two bytes of data, processes them as dictated by the program and outputs the result and the condition of the result. This data is used by the computer as the basis for all arithmetic and logic decisions made.

CONTROL — If the arithmetic and logic section can be thought of as the brains of the computer, the control section can be thought of as the "enforcer". The purpose of the control section is to transfer both control and data between the other four parts of the computer.

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BOARD MINUTES

The September meeting of the PPRAA Board was called to order at 7:50 p.m. Members present were Karl, K4DQ; Al, ADØZ; Doug, WBØMHP; and Mark, KAØJXY. There being no challenge to the lack of quorum, the meeting continued.

A generator has been purchased for the club. Cost was \$461.10 for a Honda EN1600.

The nominating committee suggested several names as nominees. These people will be contacted prior to the October meeting.

Doug reported that he and Dave have been working on organizing the Enduro which took place Sept. 26.

Karl presented a cablevision letter for review. The letter shows changes from Jan. to Sept. 1982. It will be circulated at the Oct. meeting.

There being no further business before the board, the meeting adjourned at 8:37 p.m. Next meeting will be Oct. 18th.

Respectfully Submitted,
Mark, KAØJXY

Computers (cont.)

It does this in three ways:

1. Fetch and execute an instruction — Instructions are the basis of the program being run which is stored in memory. A typical instruction might tell the control section to transfer control to the keyboard and wait for an input. The next instruction might say to transfer data from the keyboard to memory.

2. Read the condition flag register — recall that the ALU makes arithmetic and logic computations and places the condition of the result in the flag register. Depending on the data present in the flag register, the computer will branch off to read any of several subroutines specified by the program. For example, examine a typical assembly language instruction: Jump Not Zero (JNZ) INDEX. In this example, the control section will check to see if the result of the two numbers processed by the ALU was zero. In other words, the computer checks the condition flag register for a zero condition. If the result is not zero, the control "branches off" to read the first instruction in the subroutine the programmer has named "Index". If the result is zero the computer reads the next instruction following the one just executed.

3. Respond to an Interrupt Request — many kinds of peripheral equipment such as Keyboards, CRT's and printers don't operate as fast as the control section of the computer can service them. It is not good design to slow the computer down to match the speed of the slowest piece of equipment attached to it when the computer could be off performing other functions instead. In the better designs, the control section is constantly checking for "Interrupt Requests" so it can temporarily break off what it is doing, service the peripheral and return.

There are many subtle differences from computer to computer, but don't forget every one has to have the five parts discussed above or they can't technically be called a computer. If you have a good basic knowledge of the computer parts as addressed here, you will have a good foundation for understanding the next article in

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Computers (cont.)

our series which will cover microcomputers. But before we leave our example of a generic computer, let's examine one more point. As shown in Figure 1, the control section and the ALU with its associated condition flags are called the central processing unit (or CPU). It picked up this name some time ago because of the large amount of space required by vacuum tubes. That is as much of the computer that would feasibly fit in one enclosure (or along one wall).

Well the name stuck, and even though innovations in microelectronics have reduced the size so much that the entire processing unit can be placed on a single printed circuit board, we still call it the CPU. Eight bit CPUs used in microcomputers are sometimes called microprocessing units (or MPUs). You will not see that term used again in any of the remaining articles in this series. We will consistently use the terms CPU or microprocessor.

In the next article we will apply what we discussed here to microcomputers. We'll first take a look at the development of the 8 bit microprocessor. We'll then

group them into design families and discuss the good and not-so-good points of some popular brands. We'll discuss who's who in the microcomputer business. We'll also talk about what's happened to the Japanese and why they were so slow to start. We'll discuss in detail what is clearly the best 8 bit microprocessor on the market today and why it's so good. And if that isn't enough, we'll talk about who's using it and why it might be a good idea to buy stock in their company. We'll wrap up the article with a discussion of where microcomputers are heading in the near future.

Allen Bailey, ADØZ

MEETING NOTICE

The October meeting of the Pikes Peak Radio Amateur Association will be held on October 13 at 7:30 p.m. at the First United Methodist Church located at the corner of Nevada and Boulder streets. Election of Officers and Directors for 1982-83 will take place. Members and interested persons are encouraged to attend.



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